Figure 2), with associated ballast modules 16 and caps 18. The sleeves 15 are made from a material that permits passage of ultraviolet light. A preferred material is quartz glass. The ultraviolet lamps 14 and ballast modules 16 are submerged in liquid 66, e.g waste water. The surface of the liquid is shown at 17 and in Figure 1 is beneath bar 13.

Figure 2 shows the arrangement of one of the ballast modules 16. The ballast module 16 has internal components 22 encased in sleeve 21. At one end of ballast module 16 there are female electrical connectors 20 for co-operation with electrical pins 19 on ultraviolet lamp 14. At the other end of ballast module 16 there is an electrical line pin 23 and an electrical neutral pin 24. Between line pin 23 and neutral pin 24 there is an electrical insulation barrier 25. Attached to sleeve 21 is a retaining ring 26, the purpose of which will be explained hereinafter.

Figure 2 also shows vertical conduit 11 in which there are female electrical connectors 34 and 35, which are electrically connected to electrical conduits 30, e.g. wires, strips, laminates. There is an aperture 36 adjacent to connectors 34 and 35, through which pins 23 and 24 may be connected to connectors 34 and 35 respectively. Attached, e.g. welded, to vertical conduit 11 is a tubular stub 29, which has an exterior screw thread, as shown in Figure 2 and Figure 4. Ballast module 16 is held in place by means of an internally screw threaded coupling 27. The joint between ballast module 16 and tubular stub 29 is made watertight by means of an O-ring 28, which is trapped between retaining ring 26 and tubular stub 29.

As indicated above, the ultraviolet light lamp 14 is electrically connected to ballast module 16 by means of pins 19 and female connectors 20. At the end of ballast module 16 adjacent to the connectors 20, there is a tubular stub 31 that has an external screw thread 31a. Tubular stub 31 is connected to sleeve 21 by a weld or similar. It will be understood that tubular stub 31 may be an integral part of sleeve 21. Quartz sleeve 15 surrounds ultraviolet lamp 14. The connection between the quartz sleeve 15 and tubular stub 31, and thus between ultraviolet lamp 14 and ballast module 16, is kept

waterproof by means of an O-ring 33 which is trapped between tubular stub 31 and internally threaded retaining nut 32.

It will be understood that other arrangements for securing the ballast module and lamps in place are possible without departing from the essence of the invention. For example, sleeve 16 and tubular stub 29 may have the same diameter, and abutting ends may be externally threaded and held together with an internally threaded coupling which screws onto both the sleeve and the stub.

It will be understood that, although the diameter of the sleeves 21 of the ballast modules 16 are substantially the same as the sleeves 15 of the ultraviolet lamps to minimalize headloss of water flow, the diameter of between these sleeves (21, 15) may differ while maintaining a minimal of headloss.

Figure 3 shows an end of ballast module 16, which has line and neutral pins 23 and 24 separated by an electrical insulation barrier 25. The ballast module end may have auxiliary pins 38 for alarms and other communications features or instead all communications may be passed along pins 23 and 24.

It will be understood that electrical pins 23 and 24 form an electrical connection with electrical conduits 30 when pushed into female electrical connectors 34 and 35 respectively.

Although the drawings show electrical power being fed to ballast modules 16 by means of wires, strips or laminates 30 through conduit 11, electrical power may be fed to ballast module 16 through means external to conduit 11. In such an instance, waterproof wires may be used, which enter a waterproof coupling to the ballast module. As will be understood, in such an instance, conduit 11 could be replaced by a submersible tube or bar which merely supports ballast module 16. Such support may be provided by a flexible or rigid boot attached to the submersible bar.

Referring to Figure 5, there is provided a system architecture diagram of an UV water treatment site. The site has an assembly control unit 100 with an operator interface 110. Electrical energy is carried on power lines 105 to modular UV lamp rack assemblies 140 and to ballast modules 120 for supply

to UV lamps 130. Operator interface 110 provides the necessary monitoring and control information to the operator, and the controls for the operator to operate the UV lamp rack assemblies.

Communications between assembly control unit 100 and modular UV lamp rack assemblies 140 and ballast modules 120 are carried over power lines 105. Power line transceivers manufactured by Intellon Corporation may be used. Alternatively, communications may be carried over separate lines such as a twisted-pair cable utilizing RS485 communication protocol or similar.

Typically, assembly control unit **100** is a computer dedicated with appropriate input and output interfaces. Various flow or dose control algorithms and programs can be stored and executed from assembly control unit 100. Assembly control unit 100 may also have intermediate control units between the operator station and the ballast modules. Without departing from the scope of this invention, it will be understood by those skilled in the art that the ballast modules may be designed with more or less processing power and may further be programmable.

Referring to Figure 6, there is illustrated a block diagram of a ballast module 120. Electrical energy is supplied to ballast module 120 via power line 200. Ballast module 120 is composed of three main sections: power factor section 210, ballast 220, and control section 230. Output 240 of electrical energy is applied to a UV lamp.

The power factor section 210 electrically couples the power line 200 to the ballast 220 and substantially synchronizes the voltage and current of the electrical energy being used by the ultraviolet lamp as viewed by an electrical energy monitor. The power factor circuits are generally well known in the art and a number of different circuits may be used in ballast module 120. Synchronization of voltage and current is either required by some utilities or required for cheaper electricity rates. While power factoring can be performed at a central location, beyond certain power usage levels, separate facilities for electromagnetic emission suppression and cooling may also be required. It is thus advantageous to place the power factoring function within the ballast